

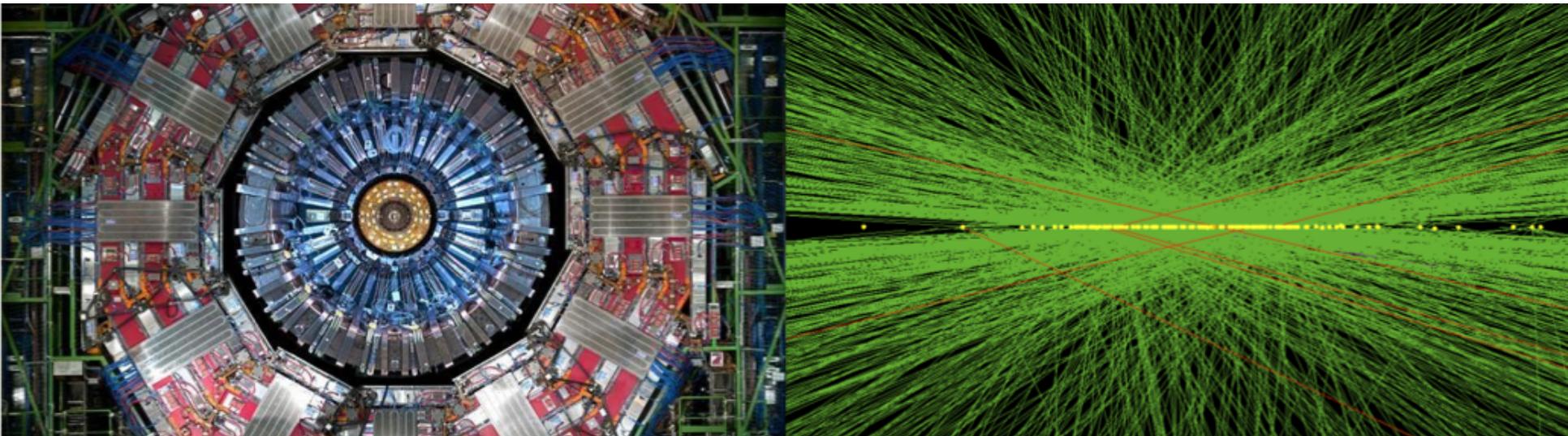


# MTD-BO 7: Remaining R&D, Readiness for CD-2, Plans for CD-3b

Chris Neu

HL-LHC CMS Upgrade CD-1 Director's Review

20 March 2019





# Outline

- Reminder of upcoming review plans
- Summary of R&D remaining
- Path to CD-2
- Early purchases

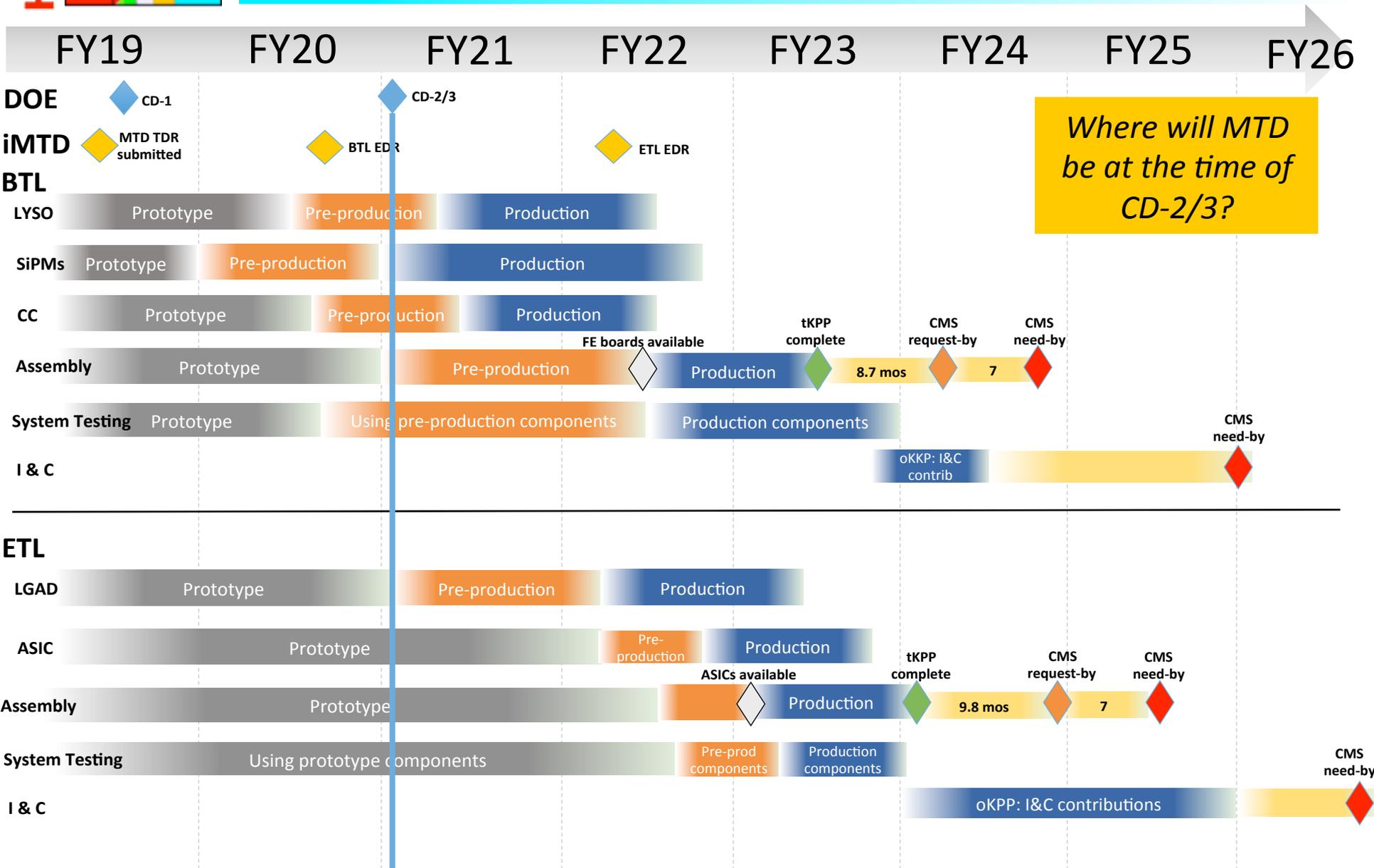


# Reminder: Upcoming Review Plans

- We are planning for the following review dates
  - CD-1 June, 2019
  - CD-3a November, 2019
    - Early procurements for Outer Tracker, Endcap Calorimeter
  - CD-3b April, 2020
    - Early procurements for MTD: LYSO and SiPMs for the BTL.
  - CD-2/3 November, 2020
    - Needed for start of construction in FY21
  
- At CD-2/3, we will have a preliminary design with a definitive scope, cost, and schedule



# US-MTD Schedule in P6



Where will MTD be at the time of CD-2/3?

# R&D Remaining

## ■ BTL:

- **LYSO:** R&D limited to production details for commercially available solutions such as choice of optical **glue**, reflective **wrappings**.
- **SiPM:** Study of **DCR evolution** as a function of dose of candidates from HPK and FBK to determine which one will provide the best timing resolution over the lifetime of the BTL. **Packaging** optimization for thermal properties.
- **Concentrator Card:** Identification of **testing** protocol as well as **readout** of the CC for testing has started. Prototype CC's in hand this summer Q3 CY2019.
- **Assembly:** Module and tray design now transitioning from conceptual to engineering design. This allows development of **assembly procedures** and mockups. Industrialization options for module production to be explored in detail.

## ■ ETL:

- **ASIC:** Evaluation of ETROC0; development of ETROC1 (4x4 w/ preamp + discriminator + TDC), ETROC2 (8x8 w/ above and all support circuitry), ETROC3 (full size 16x16, full functionality)
  - ETROC0: chips back this week
  - ETROC1: submission June ready by 2019
  - ETROC2: Q3 CY2020
  - ETROC3: Q1 CY2022
- **Assembly:** Construct modules of increasing complexity (mechanical and thermal mockups, then prototype modules with electrical functionality). Verify the full end-to-end module assembly procedure.

# CD-2/3 Readiness

- For BTL, in advance of CD-2/3 in November 2020:
  - Pre-production LYSO crystal matrices will have been evaluated, production-era crystal specification finalized, vendors chosen and **orders placed**;
  - Pre-production SiPMs will have been assessed, the specification for production-era devices completed, vendor(s) chosen and the **orders placed**;
  - Prototype CCs with prototype components (IpGBT, VL+, DCDC) will be **complete and assessed**;
  - The BTL assembly procedure will have been **defined and tested** and mechanical mockups **will have been built**;
  - Integrated BTL **system testing completed** for pre-production LYSO+SiPMs, prototype TOFHIR1 FE ASICs and CC, outfitted on a realistic cooling tray at cold temperature;
  - And an **EDR for the BTL will have been complete** by May 2020.

# CD-2/3 Readiness, continued

- And in the ETL:
  - Large-size prototype LGAD sensors corresponding to a size of between 4 and 8 ROC groupings will have been evaluated, leading to a **specification for the final LGAD sensor** geometry and doping profile;
  - Performance of ETROC1 prototype chips – a 4x4 chip w/ preamp + discriminator + TDC, ie, **the most challenging portions of the design** from a precision timing perspective – will have been evaluated;
  - Simulation of ETROC2 (8x8 w/ above and all support circuitry) will have been **completed and submitted** for fabrication;
  - The ETL assembly procedure will have been developed and pilot mechanical modules built;
  - Integrated ETL **system testing completed** using prototype LGADs, prototype ETROC1, prototype service cards and outfitted on a mockup cooling plate at cold temperature
- Hence, by CD-2/3 **we will be ready with a complete preliminary design**

## CD-2/3 Readiness, continued

- The US-MTD scope is defined now and will be formalized in the MOU process that will follow the submission of the Upgrade Cost Group review package.
- The associated costs and schedule are what has been developed in P6 for this review. This will be updated by the time of CD-2/3 to reflect technical progress.
- Hence, by CD-2/3 **we will be ready with a definitive scope, cost and schedule.**

# Early Purchases

- We are planning to participate in a CD-3b review in April 2020 to accommodate early purchases
- BTL schedule necessitates placing orders for production era components ahead of the CD-2/3 review:
  - LYSO order is to be placed in June 2020
  - SiPM order is to be placed in August 2020
- The US is planning to make large contributions to both of these commodities:
  - 40% of the required LYSO, at a direct cost of \$1.1M
  - 34% of the required SiPMs, at a direct cost of \$950k
- By April, 2020 we will be ready with the final design specification for both LYSO and SiPMs.



# Summary

- The remaining R&D in the US for MTD is understood and has a well-defined scope and plan
- Preparations are underway for a CD-3b review to enable purchases of production-era LYSO and SiPMs in Q3-Q4 FY2020
- By the time of CD-2 in Q1 FY2021, we will be ready with a complete preliminary design and defined scope with solid cost and schedule planning



Extra Material

# Biographical Sketch

## ■ Chris Neu

- L2 manager for US MTD
- Associate Professor, University of Virginia (2008-present)
- Member of the MTD Steering Group
- Served as co-convener of the MTD Simulation and Performance group through June 2018
- Previously served as co-convener in CMS subgroups associated with top-Higgs and top quark physics
- Formerly a member of CDF working on the XFT track trigger, L2 trigger upgrade for Run IIb, CMU/P upgrade, COT wire planes
- Physics interests: top-Higgs coupling, top quark measurements, dark matter